***Competency 1.8*** **Industrial hygiene personnel shall demonstrate a working level knowledge of the analysis and interpretation of sample results.**

## 1. Supporting Knowledge and Skills

a. Discuss how the following are used in the analysis of sampling results:
- Mathematical and statistical computations
- Units and conversions

b. Discuss how the following can affect the interpretation of sampling results:
- Deductive/inductive reasoning
- Environmental conditions during sampling
- Instrument limitations
- Selection of techniques
- Trend analysis
- Need for additional data

c. Discuss how the following affect the significance of exposures.
- Selection of exposure criteria (action levels, etc.)
- Individual susceptibility to identified hazards
- Affect of other non-occupational exposures
- The affect of multiple exposures
- The impact of biological sampling results
- Make-up of worker population

d. Discuss the role standards, guidelines, and legal requirements have on analyzing and interpreting results.

## 2. Recommended Reading

**Review**

- DOE Policy 450.2 Interim Policy, *Policy Statement on the Identification and Compliance With Environment, Safety, and Health Requirements*.
- *Fundamentals of Industrial Hygiene*, 3rd Edition, National Safety Council, Chapters 16, 17, and 19.
- Patty's *Industrial Hygiene and Toxicology*, 4th Edition, Volume I, Chapter 27; and 2nd Edition, Volume IIIA, Chapters 8 and 11, and Volume IIIB, Chapter 7, Clayton & Clayton.
- NIOSH *Occupational Exposure Sampling Strategy Manual*, NIOSH Pub. No. 77-173.
- OSHA *Technical Manual*, 2nd Edition, Chapter 1, "Personal Sampling For Air Contaminants" and Chapter 2, "Sampling For Surface Contamination."
- AIHA, *A Strategy for Exposure Assessment*.
- DOE Guide 440.1-3, *Occupational Exposure Assessment* (Draft for Interim Use and Comment).

## 3. Summary

Sampling should be performed with a result in mind, e.g., to determine employee exposure relative to an accepted allowable exposure limit. In order for the sampling results to be the basis for any important decisions, sampling should be personal monitoring using a nationally recognized reference method, or as described in a regulation or consensus standard.

Given an occupational exposure limit and a recognized sampling and analytical method, sampling will probably serve one of two useful purposes: (1) to determine whether exposure levels are high enough that protective controls be initiated, and (2) to determine whether exposure levels are high enough that when coupled with the frequency of exposure, or when related to other exposure, medical surveillance for the agent be initiated. Exposure above the occupational exposure limit will require the implementation of workplace controls; in general, exposure at about one-half of the occupational exposure limit for 15 days per quarter or 30 days per year would indicate the need for the medical surveillance of exposure for that agent. Exposure monitoring is also normally required to ensure the adequacy of respiratory protection, when required in atmospheres that exceed the occupational exposure limit.

The samples themselves should be representative of actual exposure conditions and the sampling performed in accordance with SOPs using quality calibrated instruments operated by qualified staff. The samples should be analyzed by an accredited laboratory. Sampling sheets should contain information describing variables that relate to the exposure level, i.e., quantity of material and concentration of agent consumed (paint and percentage of agent sampled, number of welding

rods, area of asbestos removed); workplace description, i.e., indoors, outdoors, size of room or space in which sampling was performed; controls in place if they affected airborne levels, i.e., natural or mechanical ventilation, speed of air movement; housekeeping details and idiosyncratic work practices if they affect exposure level; and documentation that the work activity was over when the sampling pump was turned off. Many of these variables must be described so that their effects on exposure may to some extent be understood and the impact of changes in variables predicted.

The number of samples should be sufficient to adequately characterize an operation. If sampling of the highest risk employees shows no significant exposure, then no more samples may be needed. If a pattern of universally high exposure is seen, then continued periodic monitoring to ensure that the level does not increase may be justified. If a pattern of exposure levels is discovered that is consistent and predicable on the basis of the variables observed, then the operation may be considered sufficiently characterized to allow future monitoring to be limited to only what is needed to verify exposure assumptions. If both low and high risk groups show occasional high exposures, it has to be determined whether additional study of variables and selected sampling may be useful, or that high exposure should be assumed universally and periodic monitoring continued for both groups.

Significant exposures to different agents that influence the same target organs require that exposure with respect to the occupational limits be determined by adding the exposures expressed as fractions of their individual limits. If the sum equals or exceeds "1", then the cumulative exposure is treated as any other overexposure requiring control, except that the overexposure is to a group of compounds rather than to one agent. If the cumulative exposure is above 0.5 and exposure is frequent, medical surveillance on the basis of exposure to the group of similarly acting chemicals should be considered.

Among the more important decisions to be made when evaluating sampling results is the interpretation of occupational exposure limits. If the goal were only to ensure strict compliance, one could not require the initiation of controls at exposure levels less than the occupational exposure limit, and medical surveillance at less than one half the allowable limit. From the point of view of the prevention of unnecessary occupational illness, however, control of exposure to levels well below the occupational exposure limits is justified for many agents. Because the health effect that is the basis of the assignment of occupational exposure limits varies between chemicals and chemical groups, the exact exposure levels to be maintained for chemicals should be determined on a case-by-case basis considering primarily the worst credible risk for that chemical, the number of employees exposed, and the cost of controls, including the impact on productivity.

## 4. Suggested Exercises

Please refer to Scenarios 5 and 6 in the Scenario section of this document.